

EARLY OPERATION IN TRAUMATIC INTRACRANIAL HÆMORRHAGE.*

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THE extreme gravity of hæmorrhage of the intracranial vessels is universally recognized, and the necessity of early interference as affording the only relief to this condition is generally accepted by surgeons, yet there are still a number of cases allowed to die from want of operation. The object of this paper therefore, is to suggest a more frequent resort to exploration of the skull in the hope of thereby saving cases which otherwise would result fatally. While no doubt recovery is possible under expectant treatment, it is equally true that many more die from want of operation, and some observers state that over ninety per cent. die under expectant treatment. Not infrequently one reads in the medical journals reports of cases which could have been saved by operation, and it is the experience of surgeons connected with the large hospitals to observe at times autopsies which reveal the fact that early resort to trephining would have been followed by success.

The failure on the part of the surgeon to operate in these cases may be ascribed to several reasons. It may be due to the extreme difficulty, or impossibility, of arriving at a diagnosis; and it must be conceded that very often from the absence of a history of the injury or from the presence of existing complications, a positive diagnosis cannot be made, and accordingly expectant treatment is indicated. It must be said, however, that inquiry into the history of a case previous to having been seen by the surgeon is at times incomplete and that a more thorough investigation reveals a history

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of trauma sufficient to justify exploration. In other cases, from the history of the injury and from the fact that symptoms of severe compression followed an apparently slight degree of trauma, the surgeon suspects or diagnoses severe contusion or laceration of the brain, and accordingly considers operation useless. The diagnosis of cerebral contusion or laceration, and especially its extent, is more or less conjectural, unless the nature of the injury is such as to allow inspection of the brain. And it is from the opinion so often expressed by surgical writers that subdural haemorrhage is usually accompanied by cerebral contusion, that an expectant attitude is advised in this variety of intracranial haemorrhage. It is a fact, however, that operation (or autopsy) has shown that cerebral contusion is by no means so frequent as is supposed, and in many instances death was solely due to compression of the brain by the blood-clot. Some authorities also do not consider the presence of contusion accompanying haemorrhage as contraindicating operation, and in the opinion of others the removal of the blood-clot has a beneficial effect upon the complicating contusion of the brain.

The absence of focal symptoms, even when the symptoms of general and increasing cerebral compression are present, is considered by some surgeons sufficient reason for desisting from operation, as information is lacking as to where the trephine should be applied. Perhaps this may apply in a few cases, but in the great majority of cases where there is a definite history of trauma, a careful examination of the scalp will reveal a contusion or abrasion which will supply the desired guide.

Another cause which bears on the question of diagnosis (and this applies mostly to the general practitioner) is the indefinite and confused idea which prevails concerning the condition known as cerebral concussion. In the average surgical text-book one reads that there may be a light degree or a severe degree of concussion and, consequently, the patient lies unconscious for a period varying from a few moments to several days. Again, we read, if the symptoms last for days,

then the diagnosis of concussion must be excluded, and some severe intracranial injury is to be suspected. If it were remembered that the symptoms of pure cerebral concussion are transient in character and that many so-called cases of severe concussion are in reality cases of compression, it would result in an earlier recognition of the condition, which at times demands early interference, and the cases would accordingly reach the surgeon while there was still a chance for relief. While perhaps a more careful inquiry into the history of trauma might lessen the difficulty of diagnosis, it would seem that the suspicion of existing cerebral contusion and also the absence of focal symptoms are not sufficiently valid reasons for desisting from operation.

Hæmorrhage may follow injuries of the various intracranial vessels, but the one most frequently involved is the middle meningeal artery, next the vessels of the pia, and finally the venous sinuses of the dura. The extent of the hæmorrhage, as well as the rapidity of its formation, depends upon the size of the injured vessels, and the result of the hæmorrhage is a diminution of the space in the cranial cavity and a corresponding degree of cerebral compression. Hæmorrhage from the trunk or a large branch of the middle meningeal artery is followed by the formation of a steadily-increasing clot which finally interferes with the entire cerebral circulation, and death follows. Should, however, the clot not be large enough to cause a high degree of intracranial tension, but of sufficient size to cause persistent pressure, it is equally dangerous, as the continued pressure causes œdema of the brain and thus adds to the increasing compression.

The symptoms of traumatic intracranial hæmorrhage are those of cerebral compression, and the main indication of treatment is the removal of the clot causing the pressure on the brain; at the same time ligation of any blood-vessels exposed by the operation.

Intracranial hæmorrhage is divided into the extradural and subdural varieties, according to the location of the clot regarding the dura, and it may be of interest to consider some

points in regard to these varieties of hæmorrhage, and in addition to report the history of some cases.

I. *Extradural Hæmorrhage*.—This variety of hæmorrhage is caused most frequently by rupture of the middle meningeal artery, less frequently by injury of the pial vessels, and occasionally by an injury of the venous sinus. Rupture of the middle meningeal artery generally occurs in connection with the fracture of the vault or base of the skull and in the majority the violence is produced by a blunt object. Should the fracture be a comminuted one, the artery may be injured by a splinter of bone or cut by the edge of a fragment. In the case of a simple fissure crossing the course of the artery, the vessels may be cut by the sharp edge of the bone which is depressed at the time of fracture; or the vessel lying in a groove is ruptured at the time the bone is fractured. The artery, owing to its greater want of elasticity, may however be ruptured without any accompanying fracture of the skull.

Of infrequent occurrence, but of importance as regards diagnosis, is the fact that the artery may be ruptured on the side of the skull opposite to that on which the violence was inflicted.

The clinical picture of rupture of the middle meningeal artery varies accordingly as the hæmorrhage takes place externally or is confined between the dura and the bone. When occurring with compound comminuted fracture, the blood may escape externally between the fragments, and the symptoms then are those of free hæmorrhage. More frequently, however, the blood from the injured vessel extravasates between the skull and the dura, detaching the latter from the bone and forming a hæmatoma, usually of good size, which exerts pressure on the underlying brain.

The symptoms of rupture of the middle meningeal artery are those indicative of general intracranial pressure, such as disturbances of consciousness, changes in the pulse and respiration, and combined with these general symptoms are those indicating local pressure of the motor area with which the artery is so closely related. The arm centre of the motor area

is the one most commonly affected, but not infrequently there may be complete hemiplegia of the opposite side of the body.

An important symptom, and by some considered as characteristic of rupture of this artery, is the so-called free or lucid interval: the interval of consciousness which precedes the signs of compression. The interval may or may not be preceded by loss of consciousness due to the shock of the injury. While its duration varies, it generally lasts but a few hours—possibly a day—and in extremely rare cases three or four days.

When the blood escapes externally, the diagnosis of rupture of the artery is easy, but in intracranial haemorrhage it is more difficult, and to operate successfully, one must not only determine the presence of the haemorrhage, but locate its site, if possible. As given in the text-books, the principal symptoms upon which a diagnosis may be based are the lucid interval, especially if it be of short duration, the hard, slow pulse (so-called pressure pulse), stertorous respiration, together with the signs of gradually-increasing hemiplegia. If, in addition to these, there are present at the point of injury a fracture, a contusion, or even an abrasion of the scalp, then the diagnosis is certain. Such a combination of distinct and characteristic symptoms, however, is unusual, and often the clinical picture is incomplete or complicated with symptoms of accompanying brain injuries.

As an example of the difficulties in arriving at a positive diagnosis, is the history of the following case:

CASE I.—W. N., 45 years of age, admitted to the New York Hospital on August 24, 1902, at 10.30 P.M.

History.—While slightly intoxicated, fell down stairs, striking on the back of his head. He was picked up somewhat unconscious and brought by ambulance to the hospital. The accident occurred half an hour previous to admission. On admission the patient was deeply unconscious; there was no reaction to irritation such as supraorbital pressure; loss of corneal reflex, pronounced exophthalmos, right pupil somewhat dilated, left pupil contracted,

full stertorous respiration (20 per minute), a bounding pulse much above normal, rate 110; no fascial or other paralysis could be determined; knee-jerk slightly increased; no ankle clonus. Careful examination of the scalp revealed a spot of œdema about the size of a dollar behind and above the right ear. The patient rapidly grew comatose, the exophthalmos increased, both pupils dilated, pulse grew more rapid and irregular, and death followed about three hours after admission.

Autopsy.—Save for a slight hepatic cirrhosis the viscera were healthy. Cranium: above and behind the right ear an ecchymotic spot, beneath which was an oblique fissured fracture about $1\frac{1}{2}$ inches long. On opening the skull, the cranial cavity on the right side was found occupied by an extradural hæmorrhage extending from the groove of the anterior branch of the middle meningeal artery backward over the occipital region, the clot measuring six inches by three inches, and one and three-quarters of an inch in thickness. The posterior branch of the middle meningeal was completely ruptured at a point directly beneath the fracture. The brain was distorted by compression of the clot, the ventricles almost completely collapsed. Otherwise the brain was entirely normal.

This case was diagnosed by the ambulance surgeon as one of alcoholism, and the patient was admitted to the medical wards, but the house physician recognized it as a case of cerebral compression. Owing to the pronounced exophthalmos, and from the fact that severe symptoms of compression followed quickly after a slight degree of tremor, he suspected that some grave intracranial lesion was present, most likely a severe laceration or contusion of the brain, and operation was considered useless. Autopsy, however, revealed the fact that the brain was uninjured and the sole cause of death was due completely to the hæmorrhage. This case is a good illustration of the fact that the diagnosis of cerebral contusion is more or less conjectural, and the autopsy revealed a condition of affairs which could have been met successfully by an explorative operation. The indications for operation were well marked, in that there was a history of trauma, a localized

contusion of the scalp at the site of violence, and the symptoms of a rapid and steady increase of intracranial pressure.

In addition to this case, the history of another which came lately under my care, may be of interest.

CASE II.—J. K., 25 years of age, messenger boy, was admitted to the New York Hospital on March 1, 1906, at 3 o'clock, A.M.

History.—Fifteen hours previous to admission the patient was thrown from a wagon to the pavement, striking on the back of the head. He was not rendered unconscious, but simply a little dazed, got up at once and went about his work for the rest of the afternoon. In the evening he complained of headache, which steadily increased so that he could not sleep, and he applied for admission to obtain relief from the pain.

Admission.—Over the external occipital protuberance there is a small, shallow scalp-wound, and on enlarging it, it was found to not involve the pericardium. No bony irregularity or depression could be felt. Pupils equal and react normally; reflexes normal; no sensory disturbances or motor paralysis. Pulse 84, temperature 100, respiration normal. General condition good. Patient is rather pale in appearance, and complains bitterly of occipital headache. Antiseptic dressing applied to the wound, and hypnotics ordered. On the following day the patient's condition remained practically the same, except that a slight degree of opisthotonus was noted. During the following night there was a free haemorrhage from the scalp wound, which somewhat relieved the headache. On March 3 the opisthotonus was well marked. No paralysis or sensory disturbances were observed; the chief complaint was still the severe headache. The pulse was somewhat diminished in frequency, rather irregular in force, and the sphygmomanometer showed a decided increase in arterial pressure. The blood-pressure at 10.30 A.M. was 190 mm.; 2.30, 214 mm., and at 7.40 P.M. 240 mm. In the evening examination of the right fundus showed the presence of a choked disk. During the night the wound again bled rather freely, and the patient slept at intervals. On March 4 the patient was quieter, complained less of headache and appeared to be more comfortable. It was noticed, however, that he was rather dull and apathetic. The

blood-pressure at 9.40 was 206, at 12.40, 208, and at 3.45, 212 mm. In the afternoon the pulse was more irregular in force and frequency than at any time before. At 6.40 p.m. the patient suddenly became unconscious and stopped breathing. Artificial respiration was resorted to and practiced for about six-and-a-half hours. During this time the patient made no effort to breathe. Spinal puncture taken at this time showed a clear fluid under no tension. The pulse became slower and weaker and finally very irregular. Some slight twitching movements were noticed on the right side of the face shortly before death, which occurred at 1.30 a.m. on March 5th.

Autopsy.—Nothing abnormal about viscera. Head: a small wound in the median line just back of the occipito-parietal suture. The scalp of the entire occipital region is infiltrated with blood; skull-cap thin, mesocephalic. Dura thin, non-adherent, but abnormally tense. Tension uniform on both sides. Internal surface smooth and glistening. A small amount of blood is found beneath the dura on the right. Occipital meninges on the right side are infiltrated with blood; convolutions of convexity markedly flattened. Base of brain shows a slight contusion on the under surface of the right frontal lobe and on the anterior surfaces of the temporo-sphenoidal lobes. Basal vessels normal. Right occipital lobe posteriorly and the posterior portion of the right lobe of cerebellum are markedly flattened. Base of skull: a large epidural blood-clot is situated in the posterior fossa on the right side extending up to the occipito-parietal suture, but not beyond the median line. This clot occupies an area about the size of the palm of the hand, and at its thickest portion measures about $1\frac{1}{4}$ cm. Corresponding to this clot there is a fracture extending from the right occipito-parietal suture near the median line downward and backward into the posterior fossa and terminating 2 cm. to the right of the foramen magnum. Aside from the slight contusions previously noted the brain is normal.

This case contains many points of interest, one of which is a lucid interval lasting four days. Usually the duration of the interval in extradural haemorrhage is limited to a few hours, and it is extremely rare to find an interval lasting as long as it did in this case. Its explanation may be due to the

location of the fissured fracture in a region where the branches of the artery are of small size, and the haemorrhage was thus a gradual one. The relief afforded to the patient by the bleeding from his wound, however, is very significant, and most probably the intracranial pressure was thus lessened, lengthening thereby the duration of the lucid interval.

The most prominent subjective symptom was the severe headache which was mainly confined to the occipital region and marked by frequent exacerbations of pain, so that the patient would cry out. This was particularly noticeable on the second and third days following the injury; on the fourth day the headache had diminished and the patient expressed himself as feeling comfortable. The sudden paralysis of the respiratory centre without previous disturbance of consciousness is very unusual, as the order of succession of the centres affected is the reverse of what we have been taught. Generally the cortex is the centre first affected by pressure, and the pons and the medulla are the last. During the four days the patient was under observation, there was nothing abnormal about the respiration both as to rate and character, and the paralysis of the respiratory centre was sudden and not preceded by cyanosis. The pulse was never very slow, the lowest being 54 in the afternoon of the third day, when there was some irregularity in tension. On the morning of the following day the irregularity had increased, but the tension was lower. The presence of disturbances of sensibility, such as contralateral anaesthesia or hyperesthesia is mentioned by some observers as indicating haemorrhage from the posterior branch of the middle meningeal artery, but in this case of posterior haematoma these symptoms were absent.

As to the diagnosis of the case the positive determination of haemorrhage was never possible, but in the afternoon of the fourth day, some four hours before the sudden paralysis of the respiratory centre, I suspected that there was haemorrhage and decided to explore the skull, but before doing so requested the house surgeon to have a neurologist examine the patient and obtain his opinion. My reasons for exploration were the

history of trauma, diminution of the headache, the fact that the man seemed rather dull, and finally the presence of a choked disk. In addition, the increase in irregularity of the pulse, together with its increased tension, added to my suspicions. The neurologist did not see the patient until two hours after the onset of respiratory paralysis, and the time of his visit was during the period of artificial respiration. From the history of the case and the sudden cessation of breathing he diagnosed a hæmorrhage into the fourth ventricle. The result of the autopsy revealed a condition of affairs which in all probability could have been satisfactorily treated by operation, and the fatal ending was due to cerebral compression from hæmorrhage.

In reviewing the history of the case while under observation, it will be recognized that there was a well-marked and increasing cerebral compression in the presence of choked disk, and an increase in blood-pressure as shown by the sphygmomanometer, but with these symptoms there was no interference with consciousness and the rational condition of the patient up to the time of the respiratory failure rather misled me. The case shows that well-marked cerebral compression is possible without interference with consciousness.

The value of the presence of a choked disk, as indicating compression, as well as the assistance of the sphygmomanometer to ascertain the degree of blood-pressure, is well illustrated in the present case; and in several later cases I have always relied upon the examination of the fundus and the use of the sphygmomanometer in determining the presence and degree of cerebral compression. The postponement of operation until the neurologist's opinion could be obtained resulted in the loss of a favorable opportunity.

An occasional cause of extradural hæmorrhage is a wound of one of the venous sinuses of the dura, and of these the superior longitudinal and the lateral sinus are the ones most frequently injured, and they are also those most easily reached by the surgeon. As a rule the injury is associated with fracture of the skull and is due to perforation by a bony splinter

or from the sharp edge of a fragment of bone. In other cases the sinus may lie in the path of some foreign body penetrating the skull from without, such as a bullet; or during an operation the sinus may accidentally be wounded by a chisel or a trephine. Owing to their want of elasticity and from their firm attachment to the skull the walls of the sinus do not collapse when wounded, and accordingly it increases the free disposition to haemorrhage and diminishes the chances of a spontaneous arrest of the same.

As regards the diagnosis, the nature of the injury may be suspected when there is a free venous haemorrhage of the wound located over the course of the sinus; should there be no chance for escape of the blood, it extravasates between the skull and dura, producing symptoms of increasing cerebral compression. The symptoms of compression, however, come on slowly, owing to the low blood-pressure in the sinus, and focal symptoms are usually absent. When associated with simple comminuted fracture, the blood may also extravasate between the skull and pericranium, forming a haematoma of increasing size, as the following case well illustrates:

CASE III.—A girl, 11 years of age, fell through a skylight, striking on her head on the floor below, a distance of some ten feet. She was stunned for a few moments, and on coming to, noticed that her nose was bleeding. A physician was called and on examination found nothing beyond a contusion of the forehead. During the following two days there was frontal headache and a swelling of the forehead gradually increasing in size. On the third day, as she was rather morose and apathetic, her parents brought her to the Out-patient Department of the New York Hospital. Over the median line of the frontal region, just at the edge of the hair, there was observed a semi-fluctuating swelling about the size of a hen's egg. An incision into it was made by the examining surgeon, and after evacuating a good-sized haematoma under the pericranium, a depressed fracture of the underlying bone was discovered. The wound was packed with sterile gauze and the patient sent into the hospital for operation. On admission the girl seemed rather dull and inclined to sleep, but

would respond to questions. There were no motor or sensory symptoms. Pulse 88, temperature 100, respiration 22. On the following day, under ether, the fracture was exposed through a crucial incision. It was found to be a comminuted depressed fracture of the frontal bone, situated a little anterior to the junction of the sagittal and coronal sutures. There was a circular area of depression about one-and-a-half inches in diameter and almost a half inch in depth at the centre, from which the separate fractures ran out radially. The depressed bone was composed of five fragments, and from the lower end of the depression, a little to the right and parallel with the median line, was a fissured fracture running toward the base of the skull. With an elevator one of these depressed fragments was removed and a very profuse venous hæmorrhage set in from beneath the edge of an adjoining fragment. Quickly removing the latter, it was seen that the hæmorrhage came from a hole about one-eighth of an inch in diameter in the wall of the superior longitudinal sinus. The bleeding was controlled by pressure with the tip of the left index-finger, while the remaining fragments and a large extradural blood-clot were removed. The clot, about two inches in diameter and extending both sides of the median line, was removed by means of pledges of gauze, combined with gentle irrigation. A sterile gauze compress, half an inch square and made up of several thicknesses, was then substituted for the finger over the sinus wound, and over the compress was packed a short strip of inch-sterile-gauze. The wound was partially closed by suture and a firm sterile dressing applied. On recovery from the anaesthetic the child was placed in an upright position in bed. The postoperative history was uneventful. Three days after operation the strip of gauze packing was removed; on the fifth day the compress over the sinus was removed. There was no recurrence of hæmorrhage, and the wound was rapidly covered with healthy granulations. On the tenth day it was noticed that whenever the child coughed, or blew her nose, small quantities of pus appeared at the lower part of the wound. On inserting a probe, it passed into a sinus leading downward for two-and-a-half inches, but no bare bone could be detected. The suppurating sinus was drained with gauze, and in no way interfered with the rapid healing of the wound. The effect of the operation on the child's disposition was quite marked,

in that her previous moroseness and apathy were followed by brightness and activity. Six weeks after the operation she was discharged with the wound healed and no symptoms of any serious effect of the injury upon the brain.

In this case the sinus was wounded by a sharp edge of one of the depressed fragments, probably the second one, as the location of the wound of the sinus corresponded exactly with the centre of the depressed area, where the edges of the fragments were sharply pointed. The absence of a scalp-wound is to be noted, as it is rather rare, since compound fractures of the skull usually accompany wounds of the superior longitudinal sinus. This accounts for the extravasation of blood between the pericranium and the skull and the gradually increasing swelling in the frontal region. Although a good-sized extradural clot existed, it was from the ability of the blood to extravasate outside of the skull that the intracranial pressure was not increased sufficiently to cause definite symptoms of cerebral compression. The main reason for seeking advice at the hospital was the gradual increase in the size of the swelling at the forehead, together with the change in the child's disposition. The physician in charge of the case previous to admission made a diagnosis of concussion and prescribed nerve tonics. This is merely mentioned as an example of the mistaken ideas which many general practitioners entertain concerning the question of cerebral concussion.

An interesting feature is the ease with which the haemorrhage at the time of operation was controlled. The opening in the wall of the vessel was large enough to allow of serious haemorrhage and until controlled by the finger it was most profuse, but with the finger during operation, and the gauze packing subsequently, the complication was readily met. As a rule, pressure is sufficient to control the bleeding from an ordinary wound of the sinus, but should it be necessary to cut through the vessel in the course of an operation, then ligation is necessary. Suture of the wound of the vessel and the application of arterial clamps have been successfully used, but in

my opinion—unless the wound be a very large one—gauze packing will do as well and is a much simpler method. It has the disadvantage of leaving an open wound, thus increasing the chances of infection, but with ordinary antiseptic precautions this danger is very small.

The appearance of pus on the tenth day at the lower edge of the wound after the girl had coughed or blown her nose, led us to suspect that the infection was due to the fissured fracture extending either into the frontal sinus or nasal cavity. This suspicion was strengthened by the discovery with the probe of a narrow sinus leading down to the base of the skull. It should be remembered also that there was epistaxis following directly after the fall. Fortunately, infection did not interfere with the wound healing, and the danger of a suppurative phlebitis was lessened by the presence of healthy granulation covering the wound of the sinus. As the dura at operation was found uninjured, and there were no symptoms at any time indicating brain injury, it is most likely that the results of the fall were limited to a fracture of the frontal bone and a wound of the underlying superior longitudinal sinus; and probably the future prognosis of the case is good.

II. *Subdural Hæmorrhage*.—Subdural hæmorrhage most frequently follows injuries of the vessels of the pia mater, less frequently a rupture of the middle meningeal artery, and occasionally an injury of a venous sinus.

When the blood extravasates into the subdural space, the anatomical conditions are more favorable for the formation of a diffuse hæmatoma, but frequently at operation the clot is found to be circumscribed, resembling the form characteristic of extradural hæmorrhage.

The etiology of subdural hæmorrhage corresponds entirely with that of extradural hæmorrhage. The symptoms are those of cerebral compression, and its clinical picture resembles so closely that of extradural hæmorrhage that, as a rule, a differential diagnosis is impossible. The lucid interval which has been emphasized by many observers as a characteristic symptom of rupture of the middle meningeal artery is also characteristic of subdural hæmorrhage.

In Vol. 59 of Guy's Hospital Reports, Bowen reports seventy-two cases of traumatic subdural haemorrhage collected from American and British sources which he has systematically studied. These cases have been divided into Class A and Class B, the former being cases of pure compression by blood-clots and not attended with contusion or laceration of the brain, the latter (B) in which compression has been complicated by the presence of lacerations and severe contusions, which were the cause of death. In sixty of the seventy-two cases there was an interval of consciousness previous to the appearance of the symptoms of compression. Bowen considers the period of lucidity which has hitherto been emphasized in relation to extradural haemorrhage, as of equal importance in subdural haemorrhage.

As regards the duration of the free interval, one is impressed when reading this article with the long period which may elapse before signs of compression appear. In the greater number of instances it was over twenty-four hours, and the longest interval was twenty-seven days. The duration of the free interval is, therefore, an important point in differentiation, and should the interval be one of days, instead of hours, it indicates subdural haemorrhage. Should, however, the lucid interval be absent, a differential diagnosis is impossible.

The course of subdural haemorrhage is generally more protracted. Cases are reported where patients, who had been unconscious for weeks, gradually regained consciousness and made a good recovery. On the other hand, very rapidly developing cases have been observed.

The compression symptoms may be general or local, and in the presence of the latter operative interference is indicated. Should, however, the general symptoms show an increase of intracranial pressure, operation is also indicated. But it is in cases where the general symptoms are those indicating a stationary condition of pressure and where focal symptoms are absent, that the surgeon may be in doubt whether to operate. It must be remembered, however, that in these cases of protracted coma, interference should not be postponed too long,

as the persistency of pressure is equally dangerous, since it favors œdema of the brain and thus increases compression. Should the patient recover without operation, cortical atrophy may result, together with degeneration of the lateral columns of the spinal cord.

The following case is an example of the difficulties which may confront the surgeon in arriving at a decision to operate:

CASE IV.—K., 21 years of age, bartender, admitted to the medical side of the New York Hospital in the morning of April 14, 1903. He was said to have fallen in a fit thirty-six hours previous to admission, and had remained unconscious ever since. On admission the patient was unconscious, but roused to resist irritation. There was an œdematosus swelling of the scalp about one inch in diameter over the right parietal eminence. No signs of depressed bone. Slight subconjunctival ecchymosis of the inner canthus of the right eye. The pupils were normal and reacted. Respiration 20, pulse 72, temperature 100. No symptoms of anaesthesia or motor paralysis; neck rigid and slightly tender; knee-jerk exaggerated; spasticity of legs; plantar reflex normal, no ankle clonus; heart and lungs normal; abdomen retracted; leucocytes 11,600; urine sp.g. 1028; no sugar or albumen, few hyaline casts; blood-pressure 170 mm. Spinal puncture, no increase in spinal pressure. Spinal fluid diffusely blood-tinged and on microscopic examination showed a few blood-cells, a few leucocytes, no organisms. In the evening temperature was 101.6, pulse 84. April 15, patient very restless all night; still unconscious. Temperature 102.4, pulse 84, blood pressure 182 mm. There is definite, but not absolute loss of power in the left lower extremity; no paralysis of face or left arm. Patient sent to the operating-room.

Operation.—Large horseshoe flap, turned down from right parietal region, exposed a fissured fracture of the skull which could be traced forward to the orbital margin and backward to be lost in the occipital bone. At a point located approximately over the upper part of the right motor-area, there was a slight depression of the lower edge of the fracture. Trehpine was applied at this point, and a button of bone about one inch in diameter removed. No comminution of the inner table was found—no epidural clot;

the dura rather dark-colored, tense and not pulsating, bulged into the trephined opening. With rongeur forceps the opening was increased to about two inches in diameter. The dura was opened through a crucial incision and a good-sized clot exposed. This was gently removed, and some dark, bloody serum, containing lacerated brain tissue, followed. After carefully sponging the cortex, there was seen a cavity extending into the brain about half an inch and large enough to admit the tip of the index-finger. The brain still bulged into the wound and prevented complete suture of dura. The scalp wound was sutured with silkworm gut up to its convexity, where a small rubber tissue drain was inserted. Mild stimulation was necessary after operation. On April 16th and 17th patient remained unconscious and there was a free discharge of bloody serum from the wound, necessitating frequent changes of dressing. On April 18th patient answered questions, but was dull. On April 19th full consciousness was regained and patient said he had been struck with a sand-club during a fight. On April 25th sutures were removed from the convexity of the wound, and on slightly retracting the flap a small hernia of the brain was discovered. On May 10th hernia had principally disappeared, and on May 22d wound was entirely healed. On June 2d patient was discharged cured. In the following autumn he had epileptic seizures, rather mild in character and at intervals of two weeks. Under the use of bromides they have disappeared, and lie has had but one seizure during the past year.

In this case the history of trauma was purposely concealed and, accordingly, the patient was admitted to the medical wards of the hospital. Careful examination having excluded all medical cause of the coma, surgical advice was requested. At my visit, on April 14th, as the history of trauma was still wanting, expectant treatment was advised, but on the following day, after diligent inquiry among patient's friends, it was ascertained that he had had an altercation. On my second visit, on April 15th, having ascertained this fact, I advocated immediate exploration of the skull. Although the symptoms of general compression had not increased and there was still absence of focal symptoms, the correctness of my advice was

proved by the operation. The presence of great intracranial pressure was a striking feature of this case at the time of operation, when the brain pressed into the trephine opening after the evacuation of the clot. This intracranial pressure continued for some days after operation, as is evidenced by the prolapse of the brain at the trephine opening found on the tenth day after operation.

The successful result in this case was due in a great measure to the removal of the clot, but the free drainage of bloody serum following the operation contributed in a great degree to keep the intracranial pressure within the desired limit.

As mentioned above, the main reason for advising operation was the history of trauma, and had I known at my first visit that the patient had been struck with a club, I should have advised immediate exploration of the skull. The epileptic convulsions which appeared after the operation were most likely the result of the cortex laceration or, maybe, due to adhesions between the scalp and the cortex, as the dura was not completely sutured. In view of the improvement, however, which has attended the use of bromides, further surgical interference is at present not indicated.

Up to within a few years the treatment of subdural haemorrhage has, as a rule, been purely expectant, but the opinions concerning the advantages of the operation have since changed. Contusion of the brain is not so frequent an accompaniment as was formerly supposed, and in the opinion of some its presence is not only not a contraindication, but by removal of the clot the cerebral circulation is improved and thus a beneficial influence is exerted on the accompanying contusion. The results of operation have been satisfactory, and the percentage of recoveries rather large. Of the seventy-two cases collected by Bowen, there are twenty-eight of recovery and forty-four deaths. Twenty of the fatal cases were not operated on for various reasons, such as mistaken diagnosis, suspicion of brain contusion, etc. Thus there were fifty-two cases operated on with twenty-eight recoveries, and

over fifty per cent, of the operations were successful. A rather significant fact, and one which suggests that the results might have been better, was that in ten of the twenty non-operated cases death was due solely to compression from haemorrhage, a condition favorable for operation. Bowen's statistics also show that contusion of the brain was an accompaniment in only one-half of the cases in his collection. Finally, the injurious effect on the cortical centres and on the spinal cord of the long-continued pressure should not be forgotten, and unless it is promptly relieved the patient is very liable to be left with permanent lesions.

As regards the more frequent resort to exploratory operation in the treatment of traumatic intracranial haemorrhage, it would seem that it is clearly indicated. While surgeons are united as to the necessity of the operation in injuries of the middle meningeal artery, which practically are the sole cause of extradural haemorrhage, they are still doubtful as to the adoption of a similar treatment in cases of subdural haemorrhage. This view is inconsistent, in that it is only rarely that the symptoms are sufficiently characteristic to allow of a differential diagnosis, and very frequently it is only by exploration that the source of the haemorrhage is ascertained. The result of haemorrhage, whether it be extradural or subdural, is always compression of the brain by the clot, and the sole indication of treatment is removal of the clot, and checking the haemorrhage. The important point for the surgeon is to recognize the presence of intracranial haemorrhage and if the symptoms of compression are severe, to immediately relieve the compression, no matter what may be the source of the haemorrhage.

While an advocate of resorting more frequently to operation, with the idea that thereby we will save many cases otherwise doomed, I am not in accord with those who advise that the skull should be opened in every doubtful case.